Research Note

NATURAL OUTCROSSING OF OKRA IN PUERTO RICO[1]

Okra, *Abelmoschus esculentus* (L.) Moench, is considered to be a normally self pollinated crop. However, with large attractive flowers, prominent nectaries, and abundant anthers arranged around a large lobed stigma, okra attracts honey bees, *Apis mellifera*, bumble bees of various species, and carpenter bees, *Xylocopa brasilianorum*, as well as other insects. Researchers working with okra to improve varieties or even to multiply seeds must know the rate of cross pollination. If the rate is very low, varieties can be grown side by side with a minimum of natural hybridization. High rates indicate that varietal purity must be preserved by such means as bagging of flowers, or by physical isolation of varieties.

Estimates of cross pollination are generally obtained by growing two varieties together, one of which is homozygous for a genetically dominant, easily recognized characteristic while the other is homozygous and recessive. Among the progeny of the second variety, hybrids from the crossing of the two varieties will show the dominant characteristic. However, if outcrossing occurs among the plants of the second variety, this outcrossing will not be detected in the progeny.

Using this kind of reasoning several investigators have measured outcrossing of okra in various parts of the world. In India, Venkataramani[2] measured outcrossing of okra to be from 4 to 31.7%. Pantoja and Erockson[3], in Brazil, found 4.6% outcrossing during cold weather when pollinating insects were inactive. Mitidieri[4] counted 35.2% hybrids in test populations, but calculated that this represented an actual outcrossing rate of 42.2%. In kenaf (*Hibiscus cannabinus*), a species with similar large flowers, outcrossing was from 1 to 24%.[5] In still another relative, cotton (*Gossypium hirsutum* L.), Kearney[6] found that dehiscing anthers come into contact with the receptive stigma just before anthesis, and that

[1] Manuscript submitted to Editorial Board June 2, 1981.

[2] Venkataramani, K. S., 1952. A preliminary study on some intervarietal crosses and hybrid vigor in *Hibiscus esculentus* L. J. Madras Univ. 22: 183–200.

[3] Pantoja, A. and H. T. Erockson, 1962. Estudos sobre a polinzação cruzada natural do quiabo. Parte da Tese de Magister Scientiae em Olericultura apresentada a Escola de Pos-Graduação da UREMG. Olericultura 2: 235–9.

[4] Mitidieri, J. and R. Vencovsky, 1974. Polinização cruzada do quiabiero em condições de campo. Rev. Agric., Brazil 49: 3–6.

[5] Tamargo, M. A. and M. O. Jones, 1954. Natural cross-fertilization in kenaf. Agron. J. 46: 456–59.

[6] Kearney, T. H., 1923. Self-fertilization and cross-pollination in Pima cotton. Bull. 1134, USDA.

cotton is thus self-pollinated, even though further cross pollination by insects can occur later.

According to Chandra and Bhatnagar,[7] the stigma of okra is normally pollinated by pollen from the same flower up to 4 hours before the flower opens, and pollen germinates and pollen tubes reach the base of the style in that period. Thus, pollen from other flowers arrives on the stigma relatively late. The opportunity for cross-fertilization is thus much reduced. The same authors report that seed production per pod is about the same whether flowers are protected from cross-pollination or whether cross-pollination is available.

Because of interest in okra at the Mayagüez Institute of Tropical Agriculture for several of its many possibilities, a brief study has been made of the amount of natural outcrossing in okra. Plants for this study consisted of the green-stemmed standard variety "Clemson Spineless," and a very red-foliaged variety purchased as "Red" okra. Both varieties breed true from seed, and can be distinguished as seedlings of one or two weeks of age by the green of the former and the large amount of red of the latter. Hybrids of the two varieties are colored red, and the seedlings are easily distinguished from those of "Clemson Spineless," but not from those of "Red."

For measurement of natural outcrossing, the two varieties were planted at three locations in small plots of 10 rows of 10 plants each, spaced 1 m apart in both directions. Plants of the two varieties were alternated in the rows. When the plants were full sized and blooming freely, all the existing fruits were removed. Thereafter, on three different dates all of the existing flowers were tagged with a colored label.

When the tagged pods matured, they were harvested and all of the pods from each variety-date-location combination were consolidated as one sample. Seeds from these samples were grown in beds in the greenhouse, and plants were judged as normal or hybrid. However, seedlings of "Red" could not be reliably divided into normal and hybrid classes. Because the probability of cross pollination of a green plant by a green or a red plant was presumably equal, the percentage of outcrossing would be approximately double the percentage of red plants in the test plantings.

Table 1 shows the data from the test. Cross-pollination occurred in all three areas and on all three dates. The rates of cross-pollination varied among the date-location combinations from 11.8 to 60%. No attempt was made to estimate differences between dates or between locations, although the data suggest such differences. These could be due to differences in weather, insect vectors, or their interactions.

[7] Chandra, S. and S. P. Bhatnagar, 1975. Reproductive biology of *Abelmoschus esculentus*. I, Reproductive behavior, floral morphology, anthesis and pollination mechanism, Acta Bot. Ind. 3: 104–13.

TABLE 1.—*Number of hybrids observed in seed lots harvested from Clemson Spineless, and estimates of percent outcrossing*

Site	Date	Plants harvested	Pods harvested	Seedlings grown	Percent hybrids	Percent outcrossing
Las Gómez,	Oct. 17, 1979	45	108	406	7.9	15.8
MITA,	Oct. 31, 1979	49	145	337	8.3	16.6
Mayagüez, P.R.	Nov. 14, 1979	49	139	364	7.1	14.2
La Jagua,	Oct. 17, 1979	39	78	370	5.9	11.8
MITA,	Oct. 31, 1979	42	109	329	27.6	55.2
Mayagüez, P.R.	Nov. 14, 1979	40	105	347	11.2	22.4
MITA farm,	Oct. 17, 1979	38	82	331	25.4	50.8
Isabela, P.R.	Oct. 31, 1979	37	74	333	13.5	27.0
	Nov. 14, 1979	39	88	319	30.0	60.0

The estimates of cross-pollination definitely show that a considerable amount of outcrossing occurred in every plot. These percentages of outcrossing are too high to tolerate when pure lots of seed are multiplied. Therefore, to avoid outcrossing, rather strong measures must be used. Bagging is suitable for production of seeds on a small scale. On a large scale, isolation of plantings is desirable. On the basis of practices with other crops, the isolation should be 100 m or more where honey bees and carpenter bees are active, and much more in the case of bumble bees. However, experimental data on this point is needed.

Rather high outcrossing rates such as seen in three instances, 51, 55, and 60%, cast doubt on the observations of Chandra and Bhatnagar,[7] unless such differences were due only to differences in variety. If efficient self-pollination begins 4 hours before the flower opens, there should be little opportunity for subsequent cross-pollination to result in seed set.

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